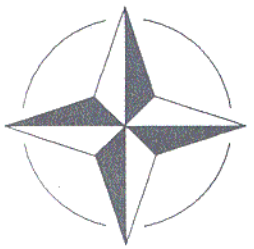


ALLIED VEHICLE TESTING PUBLICATIONS

NATO INTERNATIONAL STAFF - DEFENCE SUPPORT DIVISION

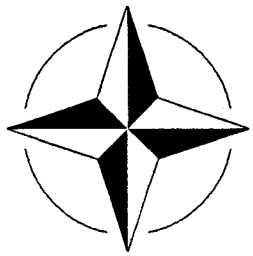
TRIAL SERIES 08

ELECTRICAL SYSTEM

AVTP	TEST TITLE
08 – 10	Electrical Supply System Characteristics
08 – 20	Electromagnetic Compatability

ALLIED
VEHICLE TESTING
PUBLICATION

AVTP : 08-10
EDITION NO.: FINAL
DATE : SEP. 1991



NATO INTERNATIONAL STAFF-DEFENCE SUPPORT DIVISION

TRIAL SERIES : ELECTRICAL SYSTEM

TEST TITLE : ELECTRICAL SUPPLY SYSTEM CHARACTERISTICS

REFERENCE : STANAG 4357
STANAG 4358

EQUIVALENT : WEU 4FT6 NO.: TM 08-10

FOR COMPLIANCE WITH : -

ABSTRACT : This AVTP describes procedures for acquiring data on the performance and reliability of the electrical system as a subsystem of a vehicle.

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NORTH ATLANTIC TREATY ORGANISATION
MILITARY AGENCY FOR STANDARDIZATION (MAS)

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6. Any ratifying nation may issue supplemental testing information to amplify or clarify these procedures, but in no case will such information contravene the provisions of this AVTP. If a ratifying nation must deviate from a provision of this AVTP due to constraints such as available facilities, national regulations, instrumentation accuracies, etc., the test methods used will be described in the report. However, such deviation may cause nonacceptance of test data by other nations.

FOR THE MILITARY AGENCY OF STANDARDIZATION

(Signature)

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RECORD OF CHANGES, AMENDMENTS AND RESERVATIONS *)

Identification of Change or Amendment and Reg.No.(if any) and date	Date Entered	NATO Effective Date	By whom entered Signature, Rank, Grade or Rate, Name of Command

*) See Reservations Overleaf

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Trial Series: ELECTRICAL SYSTEM

Test Title : ELECTRICAL SUPPLY SYSTEM CHARACTERISTICS

Paragraph

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1. SCOPE

This document describes procedures for measuring the performance of a vehicle's electrical supply system. The electrical supply system of a vehicle must provide electrical power for starting (engine heating and cranking), for supporting the central power system or engine (fuel pumps, ignition, controls), for auxiliary functions (communications, computers, light), and for mechanical power for components (turret motors, fans, gun controls) under normal and extreme conditions.
The vehicle usually has two sources of electrical power: a generator or an alternator-rectifier combination, and a battery. The battery is used to supply starting power for the vehicle and to supply electrical power during short periods of time when peak demands cannot be satisfied by the generator or alternator-rectifier. It is also used during periods of silent watch. The generator or alternator-rectifier provides charging power for the battery. To the extent that the battery must supply frequent heavy demands for electrical power, the charge in the battery can be depleted. Subsequent heavy demands for power will compromise the vehicle electrical supply system so that it cannot meet the power requirements.
This procedure does not include separate testing of components in test chambers. AVTP 03-130, Engine Cold Start, contains procedures for obtaining a required state of lead-acid battery charge.

2. FACILITIES AND INSTRUMENTATION

2.1 Facilities

a. Level paved surface.

b. Natural environment for hot and cold climate or suitable test chamber.

2.2 Instrumentation

DEVICES FOR MEASUREMENT OF:	PERMISSIBLE ERROR OF MEASUREMENT*
a. Voltage	1 %
b. Current	3 %
c. Engine speed	2 %
d. Time	1 %
e. Temperature	1 °C
f. Air Humidity	3 % of full scale

* The permissible error of measurement for instrumentation is the two-sigma value for a normal distribution; thus, the stated errors should not be exceeded in more than 1 measurement of 20.

3. REQUIRED TEST CONDITIONS

3.1 Test Vehicle

Ensure that:

a. The vehicle is prepared and equipped to the standard anticipated for operations or as specified by the test plan.

b. Maintenance and service operations have been performed so that the vehicle is operating within specifications. Give particular attention to all components of the electrical systems.

3.2 Voltage Output

The voltage output (upper and lower limits) for the different ambient temperatures during testing is to be specified in the test plan based on manufacturer specifications.

4. TEST PROCEDURE

4.1 Engine Running

a. No Load
Under normal ambient conditions and with the engine at idle, 25%, 50%, 75% and 100% of maximum operating speed, measure generator/alternator output current (optional), voltage output of the voltage regulator, and battery voltage under no-load conditions. No load conditions includes all necessary vehicle functions, e.g. for supporting the central power system or engine.

b. Component Loads (Optional)
Adjust the engine rpm's to normal cruising speed. Activate each internal electrical load in turn, record the current and voltage change at the feed to the vehicle's main electrical bus, and then turn off that load. (If the load has more than one operating position, turn it to the position requiring the most current.)

c. Total Load
With the vehicle in the same condition as specified in paragraph 4.1.b, operate all internal electrical loads and leave them on. For loads that cannot be on the same time, operate the combination of equipment that draws the most current. Record the current and voltage at the feed to the main electrical bus.

d. Maximum Supply System Capability
With engine operating, increase the load on the electrical system incrementally until the electrical supply system output reaches a maximum (loading the system to its maximum capability may require the use of an external load bank). The engine should be run at a speed at which the generating system produces maximum power. Record the voltage and the current output of the supply system.

e. Transient load conditions
With the engine operating record voltage and current transients while switching the specified components on and off.

f. Perform tests 4.1.a to 4.1.d
- in moderate cold and hot ambient temperatures as required.
- with different levels of battery charge, if required.

4.2 Engine Start

a. With the batteries fully charged and all electrical components initially turned off, start the engine. Record the current and voltage supplied by the batteries throughout the engine starting sequence. If required, repeat this test with the battery charge reduced as specified in the test plan (See Annex A to AVTP 03-130).

b. (Optional) After fully charging the batteries, shut off the engine and operate the vehicle subsystems identified in the test plan for the time required (e.g. silent watch mission). Measure the state of charge of the batteries (typically expressed by the specific gravity and voltage) both before and after operating the required subsystems. An attempt should now be made to restart the engine. Record the result of the restart attempt.

c.(Optional) After restarting the engine, record the charging current and voltage supplied to the batteries for the first 15 minutes (if the engine fails to start using the vehicle's batteries, slave the system with an external power source or use other suitable means). Record the engine speed during the recharging period.

d. Perform tests 4.2 a to c in moderate, cold, and hot ambient temperatures as required (reference AVTP 03-130 and 10-10).

4.3 Accessibility and Protection of the Electrical System

a. Check the positioning of electrical components, switches, wiring and power outlets for accessibility and safety from damage during normal usage of the vehicle.

b. Make sure adequate protection is afforded operator and maintainer personnel from contacting live electrical circuits.

4.4 Electrical System Reliability and Durability

a. Obtain data from Endurance and Reliability Tests (AVTP 11-10 and 11-20).

b. Check the functioning of the electrical system during and after completion of endurance test.

c. Inspect all components of the electrical system after the completion of the endurance test for damage, failure or undue wear.

5. DATA REQUIRED

a. Starting power supplied (maximum, surge and steady state)

b. Starting current drawn (maximum, surge and steady state)

c. Current delivered to the battery by the generator/alternator

d. Peak power surge and operating power supplied by the system as each load is turned on and off

e. Peak current surge and operating current drawn from the system as each load is turned on and off

f. Voltage and current versus time for transient load conditions

g. Voltage output of the voltage regulator

h. Battery voltage

i. Engine speed

j. Temperatures (battery, engine)

k. Environmental data

l. Reliability/endurance test data (failures and failure analysis and any safety hazards noted)

6. PRESENTATION OF DATA

Present the required data in narrative, tabular, graphical, pictorial or other format as appropriate.

Include:

a. Plots of voltage and current versus time as appropriate.

b. Temperatures versus time as appropriate.

c. Description of measurement system used (e.g. bandwidth, sampling rate, filtering, location of voltage measurement points).

ALLIED
VEHICLE TESTING
PUBLICATION

AVTP : 08-20
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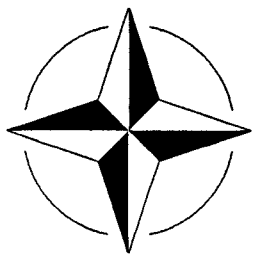
DATE : SEP. 1991



NATO INTERNATIONAL STAFF-DEFENCE SUPPORT DIVISION

TRIAL SERIES : ELECTRICAL SYSTEM

TEST TITLE : ELECTROMAGNETIC COMPATIBILITY

REFERENCE : STANAG 4357
STANAG 4358

EQUIVALENT : WEU 4FT6 NO.: TM 08-20

FOR COMPLIANCE WITH : -

ABSTRACT : This AVTP describes the test procedures for the evaluation of the Electro-Magnetic Compatibility (EMC) of vehicles.

4.07.91

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DATE : SEP. 1991

NORTH ATLANTIC TREATY ORGANISATION
MILITARY AGENCY FOR STANDARDIZATION (MAS)

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FOR THE MILITARY AGENCY OF STANDARDIZATION

(Signature)

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RECORD OF CHANGES, AMENDMENTS AND RESERVATIONS *)

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Trial Series: ELECTRICAL SYSTEM

Test Title : ELECTROMAGNETIC COMPATIBILITY

Paragraph

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DATE : JAN. 1994

1. SCOPE

This document describes the test procedures for the evaluation of the Electro-Magnetic Compatibility (EMC) of vehicles. It is assumed, in general, that these vehicles would be fitted only with automotive systems, i.e. engine electrical equipment, lights, indicators, wipers, washers, klaxons and ventilation.

It is not intended to cover vehicles with sensitive equipment for which special standards apply, particularly tests on the performance levels of equipment (See Annex C).

The aim of this document is to define the minimum test requirements necessary for the evaluation of the EMC of a vehicle against national standards.

2. FACILITIES AND INSTRUMENTATION

2.1 Facilities

Test measurement must be done in an shielded room or at an open site free of extraneous reflecting surfaces within an ellipse having a major axis of 20 m and a minor axis of 17.3 m.

The dimensions of the armoured room shall be such that the minimum distance between any of the measuring antennas and the boundary of the enclosure at their closest point shall be greater than 1 m. Therefore, the separation of the vehicle under test and the walls of the room at their closest points shall be at least 2 m.

For the radiation disturbance test, the measuring receiver should be positioned such that the horizontal distance from the measurement antenna is at least 3 m.

2.2 Instrumentation

a. Disturbance receivers or spectrum analysers with overload protection and preselection to cover the required frequency band can be used, provided that they have the following characteristics:

i) Peak detection (calibrated in terms of the effective value (RMS) of a sine wave)

ii) Nominal input impedance of 50 Ohm.

iii) Frequency accuracy ± 2 %.

iv) Voltage accuracy ± 2 dB narrow band and ± 3 dB broad band.

All measurements should be made with the following band widths, as appropriate:

i) 100 Hz < B.P. < 1 kHz, in the band 150 kHz to 1 MHz.

ii) 10 kHz ± 1 kHz, in the band 1 MHz to 30 MHz.

iii) 100 kHz ± 20 kHz, in the band 30 MHz to 1 GHz.

b. Antennas to be used for radiation disturbance measurements over the frequency range 150 kHz to 1 GHz should be as follows:

i) 150 kHz to 30 MHz, 1.04 m (41") rod (active or passive commensurate with limit level relative to measuring system noise).

ii) 30 MHz to 200 MHz, Bi-conical (measuring 0 and 90 degree polarisations).

iii) Logarithmic antenna.

c. Graphical plotters (X,Y)

d. Current probes with suitable transfer impedances commensurate with required limit and receiver noise. Accuracy of transfer impedance ± 1 dB.

e. Signal generators to cover the frequency range 1 MHz to 1 GHz.

f. H.F. power amplifiers (100 W minimum) to cover the frequency range 1 MHz to 1 GHz.

g. Transmitting antennas to cover the band 1 MHz to 1 GHz.

h. H.F. field sensors with calibration accuracy ± 2 dB.

Dependent on the automobile equipment fitted to the vehicle, test equipment may be required to function and/or test the vehicle equipment. During susceptibility testing, all test equipment must be suitably "hardened" and connected in such a manner as to minimise any extraneous coupling between the H.F. field and the vehicle.

3. REQUIRED TEST CONDITIONS

3.1 Vehicle under Test

The vehicle shall be prepared and equipped to be fully representative of the production standard. All systems shall be serviceable and capable of functioning normally during the tests. At the start of the test, the appropriate vehicle batteries shall be charged.
The engine and all electrical systems shall be switched on and allowed to reach their normal operating temperatures and the values of the electrical parameters shall be stable before commencement of the tests.

3.2 Test Site

The combined electromagnetic ambient noise and measuring receiver noise at the test site should be 6 dB below the appropriate limit of the most stringent standard in use.

4. TEST PROCEDURE

4.1 Conducted Disturbances

The test set up shall be as indicated in ANNEX A with the current probe positioned between 50 and 100 mm from the positive and negative vehicle battery poles alternatively.

With the current probe(s) in position, measure the combined ambient and measuring system noise levels.

Switch on the engine and all vehicle electrical loads. Run the engine at a speed sufficient to ensure that the generator supplies the maximum electrical current that the automobile equipment can withstand (excluding starters). Measure the H.F. current on the positive and negative lines over the frequency range of 150 kHz to 100 MHz.

Equipment that has more than one mode of operation shall be switched to that mode which produces the highest H.F. current.

4.2 Radiation Disturbances

Position each antenna, in turn, 1 m from the perimeter of the vehicle and 1 m above the ground (as measured from the points on the antennae shown in ANNEX B) at a location for maximum disturbance.

With the antenna on position, in turn, measure the combined ambient and measuring system noise.

Switch on the engine and all vehicle electrical equipment. With the engine running at a speed sufficient to ensure that the electric generator supplies the maximum current which equipment can withstand, measure the disturbances in the frequency band 150 kHz to 1 GHz.

4.3 Susceptibility to Radiation Disturbances

Place the vehicle in a sustained uniform electric field, the level and frequency of which is defined in the national standard, using suitable antennas, signal generators and H.F. power amplifiers. If the H.F. power is limited and/or the field non-uniform, the transmitting antennae shall be so positioned to ensure maximum coupling of the nominal field with each automotive equipment.

Function all the vehicle systems in this field and record any system malfunction.

Repeat the test for uniform electric field, the level of which is defined by the national standard, over the frequency band 100 MHz to 1 GHz.

If cyclical (swept) frequency facilities are not available, spot frequency testing is permitted provided that the number of test frequencies is sufficient to ensure that no potential resonant conditions are overlooked. It is recommended that a minimum number would comprise 1 MHz intervals in the H.F. band and 5 MHz intervals in the band 30 MHz to 1 GHz.

4.4 Complementary Tests

a. Repeat the test under 4.3 using amplitude modulated fields of 1 kHz (100 % square or 80 % sinusoidal) in the 1 MHz to 1 GHz band.

Additionally, at frequencies greater than 200 MHz, sustained pulse waves with a width of 1 μs and a repetition of 1 kHz shall also be used.

b. The cw and pulsed fields are applied simultaneously to give short periods of modulated signals.

5. DATA REQUIRED

5.1 General Data

- list of automotive equipment in operation
- engine speeds
- battery voltage

5.2 Conduction Disturbances

Disturbance level with respect to frequency.

5.3 Radiation Disturbances

Disturbance level with respect to frequency.

5.4 Susceptibility to Radiation Disturbances

Characteristics of the H.F. field (level, frequency, modulation) at the beginning of any operating irregularity.

6. PRESENTATION OF DATA

Present the required data in narrative, tabular, graphical, pictorial or other format as appropriate.

Include:

a. Report No. issue and date.

b. Test plan reference.

c. Nomenclature of the vehicle.

d. Description of the vehicle, serial number.

e. Date of start and completion of trial.

f. List of the test equipment used with calibration due date.

g. List of any support equipment.

h. Description of the test site or facility and the relative positions of the vehicle and of the test equipment.

i. Graphs of the combined ambient and measuring equipment noise.

j. Graphs of corrected disturbances (level with respect to frequency).

k. Tables giving:

frequencies, field strength, modulation and polarisations used during susceptibility testing, together with equipment malfunction, if any. Information shall also be provided defining positions and types of antennas.

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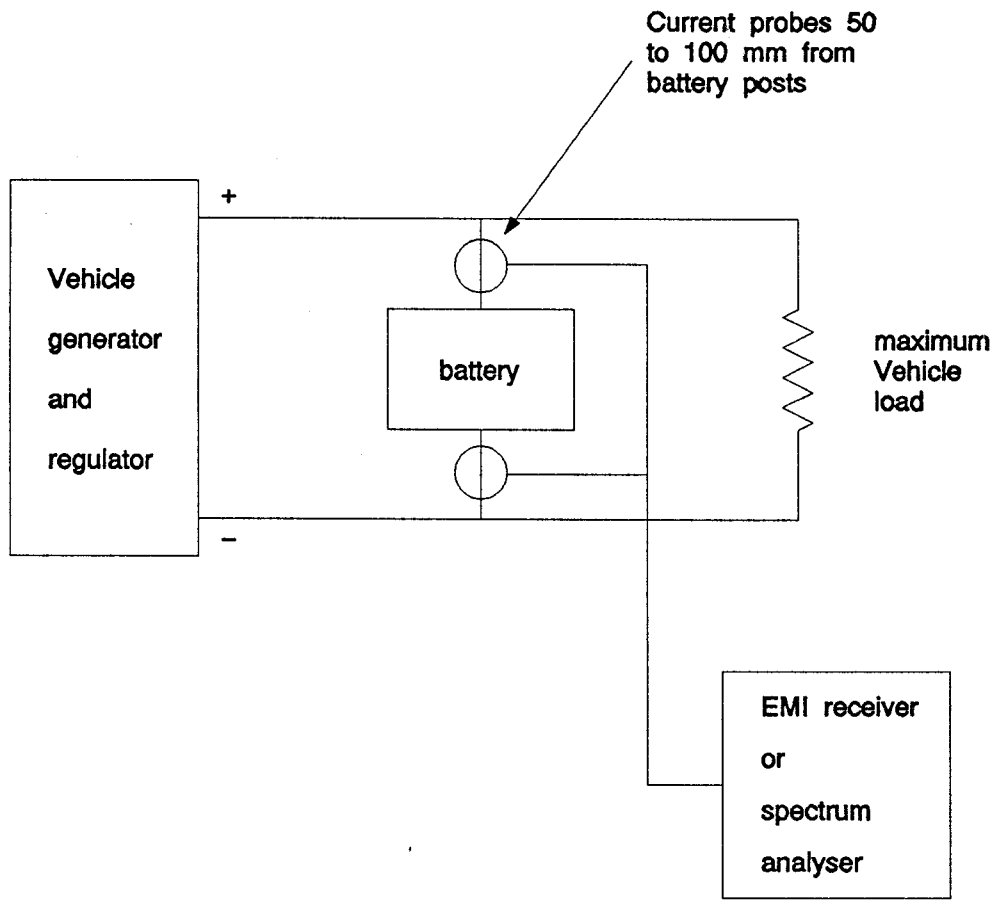
ANNEX A: CONDUCTION DISTURBANCE



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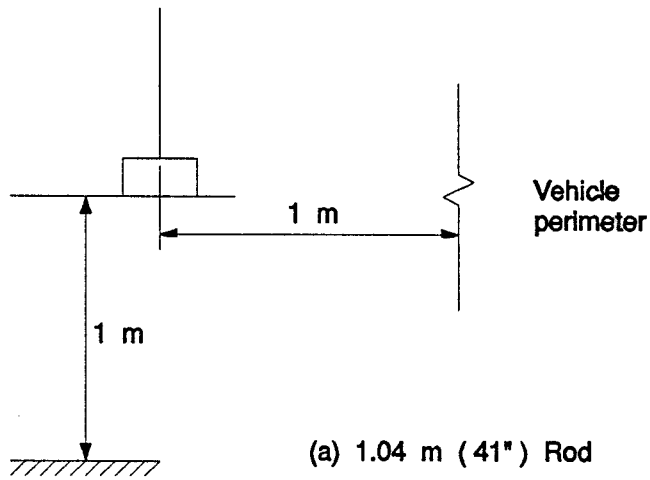
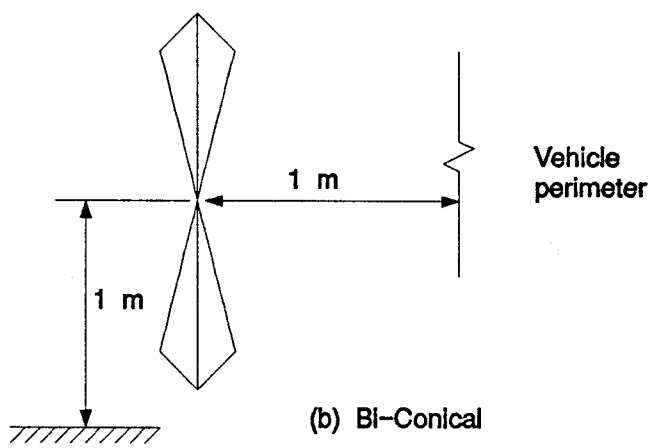
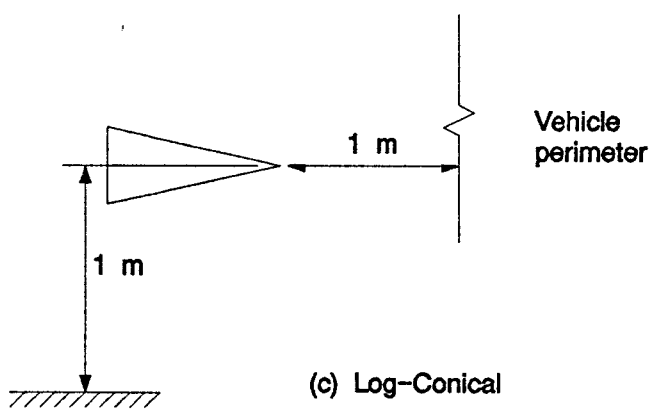
ANNEX B: RELATIVE POSITIONS OF ANTENNAS



(a) 1.04 m (41") Rod



(b) Bi-Conical



(c) Log-Conical

AVTP : 08-20
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ANNEX C: LIST OF RELEVANT NATIONAL STANDARDS

1 UNITED KINGDOM

1. Def Stan 59-41 Parts 1 to 5 Electro-Magnetic Compatibility.

2. Def Stan 61-5 Part 6 28 V DC Electrical Systems in Military Vehicles.

2 GERMANY

1. VG 95 372 Electromagnetic Compatibility Survey.

2. VG 95 370 Electromagnetic Compatibility of and in Systems.

3. VG 96 916 Electrical Systems for Land Vehicles; DC Networks 24 V; Test Requirements.

3 BELGIUM

No National specification issued. The following are used nationally:

1. Mil Std 461 Electromagnetic Emissions and Susceptibility Requirements for the Control of Electromagnetic Interference.

2. Mil Std 1275 Characteristics of 28 V DC Electrical Systems in Military Vehicles.

4 FRANCE

1. GAM-EG-13 Essais Generaux en Environnement et Matériel fascicules n° 62 et 63.

2. RAIR 2021-E Caractéristiques Generales du Réseau Electrique pour les Aéronefs.

5 UNITED STATES

1. MIL STD 461 (see 3).

2. MIL STD 1275 (see 3).

AVTP : 08-20
EDITION NO.: FINAL
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ANNEX D: DEFINITIONS AND ABBREVIATIONS

Electro-Magnetic Compatibility. The ability of electrical and electronic subsystems and systems to share the electro-magnetic spectrum and perform their desired functions without unacceptable degradation (on emission or reception) of the electro-magnetic environment.

Electro-Magnetic Interference. Any electro-magnetic emission which causes or is likely to cause an undesired response, malfunction or degradation of performance of any equipment, subsystem or system or an unacceptable degradation of the electro-magnetic environment.

Susceptibility to Radiation Disturbance. Assessment of the immunity of equipment, subsystems or systems under test to RE.

Conducted Disturbance. Desired or undesired electro-magnetic energy propagated along a conductor.

Radiated Disturbance. Desired or undesired electro-magnetic energy in free space or propagated by radiated field.

Bandwidth. A continuous range of frequencies over which the gain (of a disturbance receiver) does not differ from its maximum by a specified amount.